January 2002

Biology 30

Grade 12 Diploma Examination

Alberta
LEARNING

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Biology 30

Grade 12 Diploma Examination

Description

Time: This examination was developed to be completed in 2.5 h; however, you may take an additional 0.5 h to complete the examination.

This is a **closed-book** examination consisting of

- 48 multiple-choice and 8 numerical-response questions, of equal value, worth 70% of the examination
- 2 written-response questions, of equal value, worth 30% of the examination

This exam contains sets of related questions.

A set of questions may contain multiple-choice and/or numerical-response and/or written-response questions.

Tear-out data pages are included near the back of this booklet.

Note: *The perforated pages at the back of this booklet may be torn out and used for your rough work.* ***No marks*** *will be given for work done on the tear-out pages.*

Instructions

- You are expected to provide your own calculator. You may use any scientific calculator or a graphing calculator approved by Alberta Learning. **NEW**
- You are expected to have cleared your calculator of all information that is stored in the programmable or parametric memory. **NEW**
- Use only an HB pencil for the machine-scored answer sheet.
- Fill in the information required on the answer sheet and the examination booklet as directed by the presiding examiner.
- Read each question carefully.
- Consider all numbers used in the examination to be the result of a measurement or observation.
- If you wish to change an answer, erase **all** traces of your first answer.
- Do not fold the answer sheet.
- The presiding examiner will collect your answer sheet and examination booklet and send them to Alberta Learning.
- Now turn this page and read the detailed instructions for answering machine-scored and written-response questions.

Multiple Choice

- Decide which of the choices **best** completes the statement or answers the question.

- Locate that question number on the separate answer sheet provided and fill in the circle that corresponds to your choice.

Example

This examination is for the subject of

A. biology
B. physics
C. science
D. chemistry

Answer Sheet

● Ⓑ Ⓒ Ⓓ

Numerical Response

- Record your answer on the answer sheet provided by writing it in the boxes and then filling in the corresponding circles.

- If an answer is a value between 0 and 1 (e.g., 0.25), then be sure to record the 0 before the decimal place.

- **Enter the first digit of your answer in the left-hand box. Any boxes on the right that are not needed are to remain blank.**

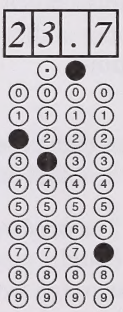
Examples

Calculation Question and Solution

The average of the values 21.0, 25.5, and 24.5 is _____.
(Round and record your **answer to one decimal place** in the numerical-response section on the answer sheet.)

Average = (21.0 + 25.5 + 24.5)/3
= 23.666…
= 23.7 (rounded to one decimal place)

Record 23.7 on the answer sheet →



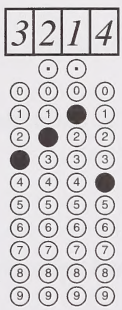
Correct-Order Question and Solution

When the following subjects are arranged in alphabetical order, the order is _____.
(Record all **four digits** of your answer in the numerical-response section on the answer sheet.)

1 physics
2 chemistry
3 biology
4 science

Answer 3214

Record 3214 on the answer sheet →



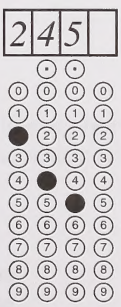
Selection Question and Solution

The birds in the following list are numbered _____.
(Record your answer **in lowest-to-highest numerical order** in the numerical-response section on the answer sheet.)

1 dog
2 sparrow
3 cat
4 robin
5 chicken

Answer 245

Record 245 on the answer sheet →



Written Response

- Write your responses in the examination booklet as neatly as possible.
- For full marks, your responses must address **all** aspects of the question.
- Descriptions and/or explanations of concepts must include pertinent ideas, diagrams, calculations, and formulas.
- Your responses must be presented in a well-organized manner using complete sentences and correct units.
- Relevant scientific, technological, and/or societal concepts and examples must be identified and made explicit.

Additional Instructions for Students Using Word Processors

- Keep all work together. Diagrams, graphs, calculations, etc. should be placed directly on your word-processed pages.
- Staple your final printed work to the page indicated for each word-processed response.
- Indicate in the space provided on the back cover that you attached word-processed pages.

Use the following information to answer the first three questions.

> The thyroid gland secretes the hormones thyroxine and calcitonin. Embedded in the thyroid gland are the four parathyroid glands. The parathyroid glands secrete the parathyroid hormone (PTH). Calcitonin and PTH work antagonistically to maintain homeostasis of calcium ion concentrations in the blood. High levels of calcium ions stimulate the secretion of calcitonin, which causes deposition of calcium in the bones.

1. Low levels of calcium ions in the blood cause

A. decreased secretion of PTH and increased deposition of calcium in the bones

B. decreased secretion of calcitonin and increased deposition of calcium in the bones

C. increased secretion of PTH and movement of calcium from the bones to the blood

D. increased secretion of calcitonin and movement of calcium from the bones to the blood

2. The release of thyroxine from the thyroid is directly regulated by

A. TSH
B. TRH
C. iodine
D. thyroxine

3. A characteristic symptom of hyperthyroidism, a disorder of the thyroid gland, is

A. lethargy
B. weight loss
C. intolerance to cold
D. slowed mental processes

---

4. Which of the following hormones plays a role in returning the salt concentration in the blood to homeostatic levels following heavy exercise?

A. Cortisol
B. Thyroxine
C. Aldosterone
D. Epinephrine

Use the following information to answer the next question.

Chemicals found in alcohol and tea have a diuretic effect. Diuretics cause the body to produce greater-than-normal volumes of urine.

5. Diuretic chemicals counteract the effect of the hormone

A. ADH
B. insulin
C. cortisol
D. prolactin

Use the following information to answer the next five questions.

Multiple sclerosis (MS), a disease of the nervous system, typically has symptoms of uncontrolled muscle responses, weakness, paralysis, and vision difficulties. Researchers believe that MS occurs as a result of the body's immune system destroying the myelin sheath that surrounds the axon of a nerve cell. The result is a scarring of brain tissue or of spinal cord tissue.

6. Damage to the myelin sheath of an optic neuron affects the speed of neural transmission to the visual centre, which is found in which lobe of the cerebrum?

A. Frontal lobe
B. Parietal lobe
C. Occipital lobe
D. Temporal lobe

Numerical Response

1. Another symptom of MS is an exaggerated pupillary light reflex. Some of the events that occur during this reflex are listed below.

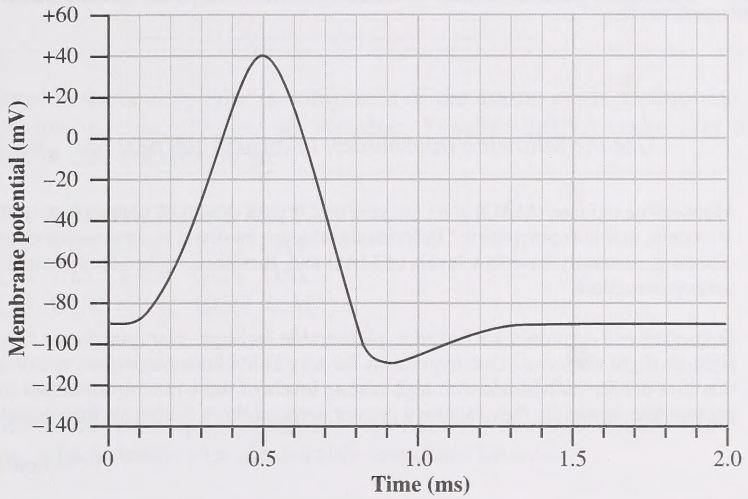
1 Motor neuron depolarizes
2 Sensory neuron depolarizes
3 Interneuron depolarizes
4 Light receptors stimulated

The order in which the events listed above occur during a pupillary light reflex is _____, _____, _____, and _____.

(Record all **four digits** of your answer in the numerical-response section on the answer sheet.)

Use the following additional information to answer the next three questions.

Stimulation of a sensory neuron produces an action potential. An abnormal pattern in this action potential can be used to detect MS in its early stages. The graph below illustrates the membrane potential of a normal neuron after stimulation.



Numerical Response

2. What is the resting membrane potential for this neuron, expressed to two digits, **and** what is the maximum membrane potential during depolarization, expressed to two digits? (Record your answers as absolute values.)

Answers: ____ ____ , ____ ____

Membrane Potential:	**Resting**	**Maximum During Depolarization**

(Record all **four digits** of your answer in the numerical-response section on the answer sheet.)

7. Which of the following types of ion movement across an axon membrane would cause the action potential to change during the interval from 0.2 ms to 0.4 ms?

A. Sodium ions moving into the axon
B. Sodium ions moving out of the axon
C. Potassium ions moving into the axon
D. Potassium ions moving out of the axon

8. On the graph, the period from 0.5 ms to 1.0 ms represents the neuron's

A. refractory period, which is when repolarization occurs
B. refractory period, which is when minimum depolarization occurs
C. threshold period, which is when repolarization occurs
D. threshold period, which is when minimum depolarization occurs

---

Use the following information to answer the next four questions.

Monoamine oxidase (MAO) is an enzyme that breaks down the neurotransmitters dopamine, serotonin, and norepinephrine. Individuals who are involved in extreme sports, such as rock climbing, generally have low levels of MAO and, therefore, higher-than-normal levels of these neurotransmitters.

Dopamine and serotonin are linked to pleasurable feelings. Norepinephrine is released in the fight-or-flight response. One hypothesis for why individuals participate in extreme sports is that in order for individuals with high resting levels of these neurotransmitters to achieve a pleasurable sensation, they require a greater surge of these chemicals than do other people.

—from *Zorpette, 1999*

9. The site in the neural pathway where MAO is active is the

A. axon
B. synaptic cleft
C. cell body
D. Schwann cell

10. The area of the brain that normally initiates the fight-or-flight response is the

A. pons
B. cerebrum
C. cerebellum
D. hypothalamus

Use the following additional information to answer the next two questions.

> Serotonin stimulates the release of endorphins, and endorphins eventually cause the release of more dopamine. Studies of individuals involved in extreme sports have found that these people have lower-than-normal numbers of two of the five types of dopamine receptors.
>
> —from *Zorpette, 1999*

11. The endorphin met-enkephalin is comprised of the amino acids methionine, phenylalanine, glycine, glycine, and tyrosine. Possible mRNA codons for the production of met-enkephalin are

A. ATG TTT GGT GGT TAT
B. ATG TTG GGC GGC TAT
C. AUG UUC GGT GGT UAC
D. AUG UUU GGC GGC UAC

12. When individuals participate in extreme sports, their neurons release more dopamine, which results in a pleasurable sensation because

A. less serotonin is released from neurons
B. more dopamine receptors are produced
C. the fight-or-flight response is inhibited
D. a neuron containing dopamine receptors reaches threshold depolarization

Use the following information to answer the next two questions.

New research has led to advances in the development of male contraceptives. One of the most promising contraceptive methods involves injecting androgens (testosterone or other male hormones) into a male's muscles. The androgens produce a negative feedback effect on the hypothalamus and pituitary gland. In trials involving a combination of androgens, sperm counts were reduced to zero in test subjects, but this method was effective for only three weeks.

Events in a Negative Feedback Loop Controlling Sperm Production

1 Production of sperm is inhibited
2 Hormone levels in the blood return to normal
3 Production of FSH and LH is inhibited
4 High levels of the injected androgens circulate in the blood

—from *Alexander, 1999*

Numerical Response

3. The order in which the events listed above would occur following the injection of androgens into a male's muscle is _____, _____, _____, and _____.

(Record all **four digits** of your answer in the numerical-response section on the answer sheet.)

Use the following additional information to answer the next question.

Researchers developing male contraceptives have found other methods of interfering with various stages of sperm development and sperm release from the body. Some methods of contraception currently being investigated are given below.

1 Interfering with the process of meiosis by which sperm are produced
2 Blocking the release of hormones that stimulate the release of FSH and LH
3 Using removable polyurethane plugs to block the tubes that transport sperm
4 Administering a calcium-blocking drug that interferes with the final maturation of sperm

Numerical Response

4. Match each of the methods of contraception described above with the structure given below that is targeted by that method.

Method of Contraception:	_____	_____	_____	_____
Structure:	**Seminiferous tubules**	**Epididymis**	**Vas deferens**	**Hypothalamus**

(Record all **four digits** of your answer in the numerical-response section on the answer sheet.)

Use the following information to answer the next three questions.

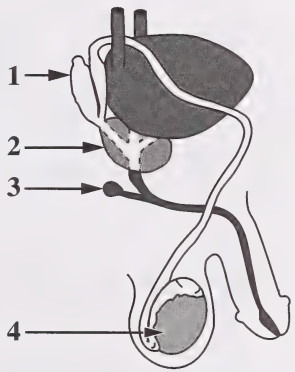
> Benign prostatic hyperplasia (BPH), an enlargement of the prostate gland, causes urination problems such as dribbling and pain. BPH is not a precursor to prostate cancer. Prostate cancer is linked to the absence of a protein coded for by the *p27* gene. The absence of this protein leads to uncontrolled cell growth in prostate tissue.
>
> —from *Seppa, 1998*

13. The movement of which of the following substances could **not** be affected by BPH?

A. Urine
B. Sperm
C. Testosterone
D. Seminal vesicle secretions

Use the following additional information to answer the next question.

Some Male Reproductive Structures



14. In the diagram above, the structure **most affected** by the absence of the protein coded for by the *p27* gene is numbered

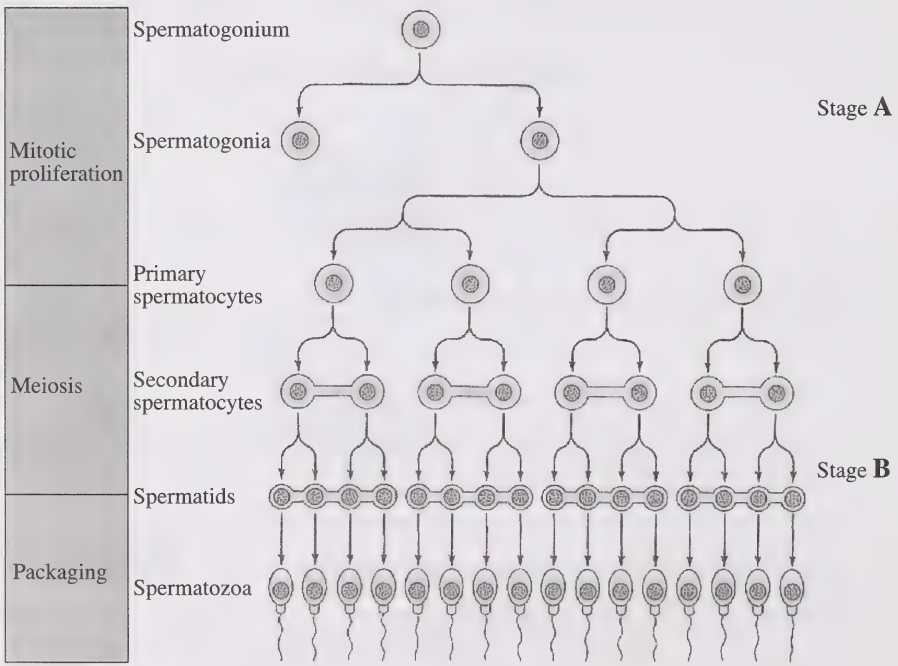
A. 1
B. 2
C. 3
D. 4

15. In normally functioning cells, the protein coded for by the *p27* gene is produced continuously. The process by which the *p27* gene's code is read from the DNA and the name of the molecule formed in the process are identified in row

Row	Process	Molecule
A.	transcription	mRNA
B.	translation	mRNA
C.	transcription	tRNA
D.	translation	tRNA

Use the following information to answer the next two questions.

Human Spermatogenesis



—from *Waller and Waller, 1994*

16. The mitotic proliferation stage of spermatogenesis occurs in the

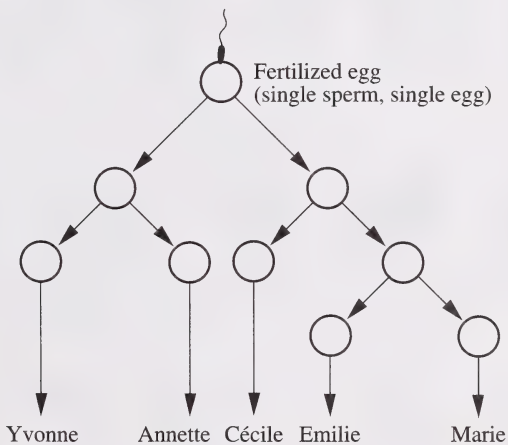
A. epididymis
B. vas deferens
C. seminal vesicles
D. seminiferous tubules

17. The chromosome number at stage **A** and the chromosome number at stage **B** are, respectively,

A. 46 and 46
B. 46 and 23
C. 23 and 46
D. 23 and 23

Use the following information to answer the next question.

The birth of the Dionne Quintuplets on May 28, 1934, near Callander, Ontario, surprised the world. The quintuplets had a combined weight of 6 kg, and theirs was the first known case in which all members of a quintuplet set survived. The process by which the quintuplets were formed is thought to be as diagrammed below.



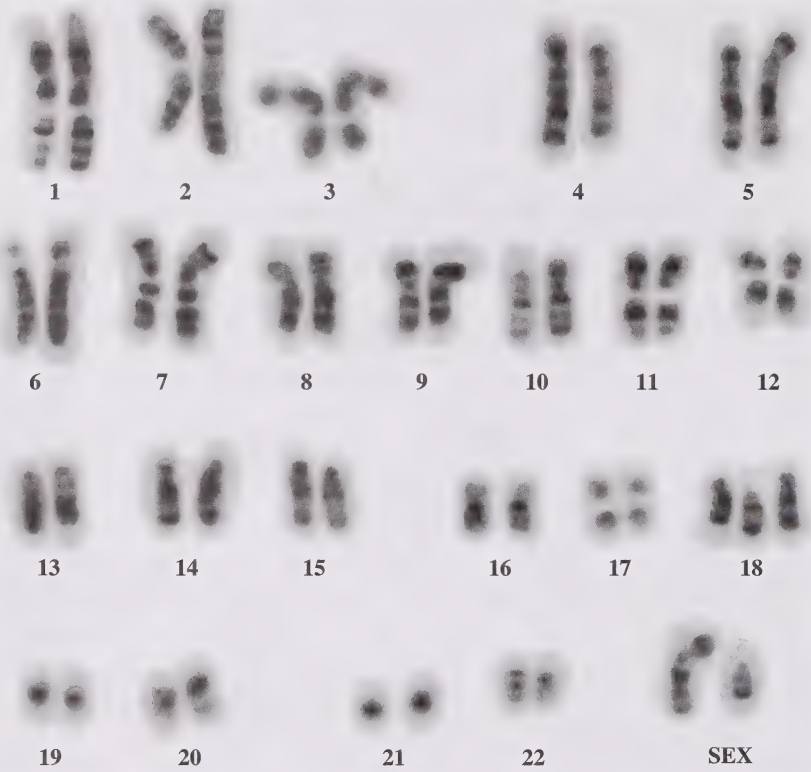
—from *Cummings, 1994*

18. The development of the Dionne Quintuplets was **most likely** the result of

A. pre-embryo splitting, which resulted in fraternal quintuplets
B. pre-embryo splitting, which resulted in identical quintuplets
C. fertility drugs, which resulted in multiple ovulation and produced fraternal quintuplets
D. fertility drugs, which resulted in multiple ovulation and produced identical quintuplets

Use the following information to answer the next three questions.

Most autosomal trisomies are lethal. The average survival age for infants with Patau syndrome (trisomy 13) is six months. Infants with Edward syndrome (trisomy 18) survive, on average, only two to four months. Individuals with Down syndrome (trisomy 21) can survive into adulthood. In order to identify autosomal trisomies, chorionic villus sampling (CVS) can be used to obtain cells that are then used to create a karyotype like the one shown below.



19. The sex and the condition of the individual whose karyotype is shown above are given in row

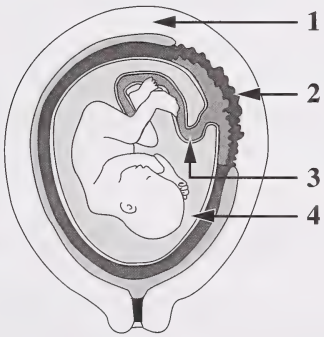
Row	Sex	Condition
A.	female	Patau syndrome
B.	female	Down syndrome
C.	male	Edward syndrome
D.	male	normal

20. The villus region sampled using CVS develops from the

A. amnion
B. chorion
C. ectoderm
D. endoderm

Use the following additional information to answer the next question.

A Developing Fetus and Associated Structures



21. Progesterone and HCG, which are used to maintain the developing fetus, are both produced in the structure numbered

A. 1
B. 2
C. 3
D. 4

Use the following information to answer the next six questions.

> Mutated mitochondrial DNA has been linked with many disorders. For example, mitochondrial DNA mutations are believed to cause approximately 1.5% of all cases of diabetes mellitus. Type I diabetes mellitus is characterized by low insulin levels. In addition to insulin, blood glucose can be affected by glucagon.
>
> —from *Wallace, 1997*

22. Which of the following statements summarizes the effect of insulin and the effect of glucagon on blood glucose levels?

A. Both insulin and glucagon tend to raise blood glucose levels.

B. Both insulin and glucagon tend to lower blood glucose levels.

C. Insulin tends to raise blood glucose levels; whereas, glucagon tends to lower blood glucose levels.

D. Insulin tends to lower blood glucose levels; whereas, glucagon tends to raise blood glucose levels.

Use the following additional information to answer the next four questions.

> A deletion mutation in mitochondrial DNA causes Kearns–Sayre syndrome (KSS). A large sample of different types of somatic cells was removed from a male with KSS, tested, and found to contain the deletion. The only type of mitochondrial DNA that was found in somatic cells from the man's mother was mitochondrial DNA that did not have the KSS deletion.

23. A reasonable hypothesis to explain these results is that the mutation in the mitochondrial DNA that caused KSS in the man first occurred in the

A. mother's oocytes
B. man's somatic cells
C. man's spermatocytes
D. mother's somatic cells

24. Both males and females can be affected by mitochondrial mutations, but only females can transmit genetic mutations to their offspring. For this inheritance pattern, which of the following rows gives the contributions to the zygote made by the sperm and by the egg?

Row	Sperm Contribution	Egg Contribution
A.	nuclear contents only	both nuclear and cytoplasmic contents
B.	both nuclear and cytoplasmic contents	nuclear contents only
C.	neither nuclear nor cytoplasmic contents	both nuclear and cytoplasmic contents
D.	both nuclear and cytoplasmic contents	neither nuclear nor cytoplasmic contents

25. Mitochondrial DNA and nuclear DNA both code for the formation of proteins. Which of the following statements about protein synthesis is **true**?

A. An mRNA anticodon binds with an amino acid codon, which results in the placement of a specific tRNA molecule in the polypeptide chain.

B. An mRNA anticodon binds with a tRNA codon, which results in the placement of a specific polypeptide molecule in the amino acid chain.

C. A tRNA anticodon binds with an mRNA codon, which results in the placement of a specific amino acid molecule in the polypeptide chain.

D. A tRNA anticodon binds with a polypeptide codon, which results in the placement of a specific mRNA molecule in the amino acid chain.

Use the following additional information to answer the next question.

In an individual with KSS, part of the coding strand of mitochondrial DNA that has been deleted has the following base sequence.

ACC TCC CTC ACC AAA

26. The third amino acid coded for by this segment of mitochondrial DNA is

A. lysine
B. threonine
C. glutamate
D. phenylalanine

Use the following additional information to answer the next question.

Over time, mitochondrial DNA accumulates non-lethal mutations at a constant rate. There is a higher degree of variation in mitochondrial DNA in earlier populations than in more recent populations. Scientists have taken samples of mitochondrial DNA from people living on different continents and compared the number of mitochondrial DNA mutations in these samples. They used this data as evidence to determine the order in which Earth's continents were populated.

27. In this study, the manipulated variable was the

A. amount of mitochondrial DNA tested
B. time of migration from one continent to another
C. amount of variation in mitochondrial DNA base sequences
D. geographic location of subjects whose sample of mitochondrial DNA was tested

Use the following information to answer the next three questions.

Tobiano Twin Colts

—Ramirez, 2000

Descriptions and Symbols Used to Represent One Type of Coat Colour in Horses

1	2	3	4
DNA sequence for coat colour	*TT, Tt*	*T*	Tobiano (white spotting pattern)
	tt	*t*	Not tobiano (no white spotting pattern)

Numerical Response

5. Using the numbers above, match these descriptions and symbols with the term below to which they apply.

Description or Symbol Number:	_____	_____	_____	_____
Term:	**gene**	**allele**	**phenotype**	**genotype**

(Record all **four digits** of your answer in the numerical-response section on the answer sheet.)

28. What are the genotypes for coat colour of two horses that are predicted to produce offspring in a 1:1 genotypic ratio?

A. *Tt* and *tt*
B. *Tt* and *Tt*
C. Tobiano and tobiano
D. Tobiano and not tobiano

Numerical Response

6. Given that the diploid number for horses is 64, what is the number of chromosomes found in a horse's somatic cell **and** what is the number of chromosomes found in a horse's gamete cell?

Number of Chromosomes: _____ _____ , _____ _____
Cell Type: **somatic cell** **gamete cell**

(Record all **four digits** of your answer in the numerical-response section on the answer sheet.)

Use the following information to answer the next six questions.

Cat coat colour results from the interaction of three different genes. A gene for black-based colours is located on an autosomal chromosome. A gene for red-based colours is located on the X chromosome. A different gene located on a separate autosomal chromosome determines pigment density in cat hair.

The black-based gene has three possible alleles: *B*–black, *b*–chocolate, and b^l–cinnamon. If pigmentation in cat hair is dense, the phenotypes listed below are possible.

Genotype	Phenotype
BB, Bb, Bb^l	black
bb, bb^l	chocolate
b^lb^l	cinnamon

29. According to the data above, the relationship among these alleles is such that the

A. black allele is codominant with the chocolate and cinnamon alleles

B. black allele is codominant with the chocolate allele, and the chocolate allele is codominant with the cinnamon allele

C. black allele is dominant over the chocolate and cinnamon alleles, and the chocolate allele is dominant over the cinnamon allele

D. black allele is dominant over the chocolate and cinnamon alleles, and the chocolate and cinnamon alleles are codominant

Use the following additional information to answer the next two questions.

There are two alleles for the pigment-density gene: dense pigment (*D*) and dilute pigment (*d*). The chart below shows the interaction of two autosomal genes affecting coat colour—the black-based gene and the density gene.

Black-based pigment gene	**Density gene**	
	D_	***dd***
*B_*	*B_D_* black colour	*B_dd* blue colour
bb; bb^l	*bbD_; bb^{l}D_* chocolate colour	*bbdd; bb^{l}dd* lilac colour
b^{l}b^l	*b^{l}b^{l}D_* cinnamon colour	*b^{l}b^{l}dd* fawn colour

30. A blue-coloured female cat is bred with a cinnamon-coloured male cat. The offspring produced are black-coloured, blue-coloured, chocolate-coloured, and lilac-coloured. The genotypes of the parental cats are indicated in row

Row	**Female Cat**	**Male Cat**
A.	*Bb^{l}dd*	*b^{l}b^{l}Dd*
B.	*Bb^{l}dd*	*b^{l}b^{l}DD*
C.	*Bbdd*	*b^{l}b^{l}Dd*
D.	*Bbdd*	*b^{l}b^{l}DD*

31. A black-coloured female cat with the genotype *BbDd* is bred with a fawn-coloured male cat. The percentage of their offspring predicted to be chocolate-coloured is

A. 13%
B. 19%
C. 25%
D. 50%

Use the following additional information to answer the next three questions.

In cats, red pigmentation is dominant to black pigmentation. The red pigment gene, which is located on the X chromosome, has two alleles: X^R and X^r. Cats with at least one X^R allele have some orange-coloured hair as a result of having the red-based pigment. Cats with only X^r alleles have no red-based pigment. Male cats with the X^R allele will be orange. However, female cats express the genes on only one X chromosome in each cell. This expression is random. Therefore, an orange-and-black (tortoiseshell) female cat is possible if it is X^RX^r. Some genotypes and their resulting phenotypes are shown below. In all cases, pigment density is high.

Genotype	**Phenotype**
X^RYBb	Orange male cat
X^rYBb^l	Black male cat
X^RX^rBb	Orange-and-black female cat (tortoiseshell)

32. The phenotype of a female cat with genotype $X^rX^rBb^l$ would be

A. a black cat
B. an orange cat
C. an orange-and-black cat
D. an orange, black, and cinnamon cat

33. A cinnamon-coloured male cat ($X^rYb^lb^l$) is bred with an orange-coloured female cat (X^RX^RBB). What possible phenotypes could be produced in the offspring?

A. Tortoiseshell-coloured female cats and orange-coloured male cats

B. Tortoiseshell-coloured female cats, black-coloured female cats, and black-coloured male cats

C. Cinnamon-coloured male cats, orange-coloured female cats, and tortoiseshell-coloured female cats

D. Cinnamon-coloured male cats, black-coloured male cats, black-coloured female cats, orange-coloured female cats, and tortoiseshell-coloured female cats

Use the following additional information to answer the next question.

When the three genes that code for black-based colour, red-based colour, and density combine, they produce other coat colours in cats.

34. What is the predicted phenotype of a female cat with genotype $X^RX^RBb^ldd$?

A. Black
B. Orange
C. Cinnamon
D. Cream (light orange)

Tortoiseshell-Coloured Cat with White Patches

Use the following information to answer the next six questions.

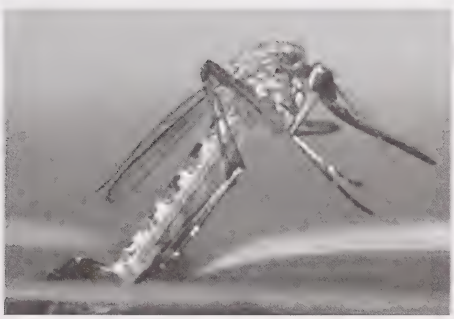
Sickle cell anemia is an autosomal recessive genetic disorder. Because individuals affected by sickle cell anemia have defective hemoglobin proteins, their blood cannot transport oxygen properly. There appears to be a relationship between the incidence of malaria and sickle cell anemia. Individuals with sickle cell anemia and carriers of the sickle cell allele have some resistance to malaria. Malaria is caused by the parasite *Plasmodium* and is transmitted between humans by mosquitoes.

35. The probability of two carrier parents having a child with sickle cell anemia is

A. 25%
B. 50%
C. 75%
D. 100%

36. If scientists are successful in significantly reducing or eliminating malaria, the **best** prediction for what will happen to the allele for sickle cell anemia in the population is that it will

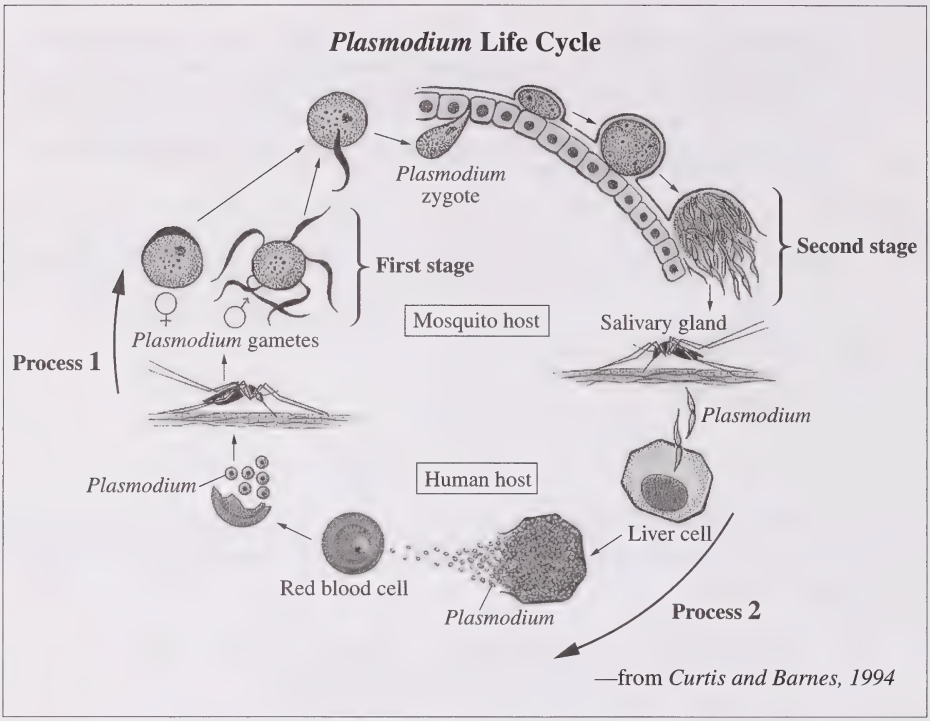
A. not be affected by the elimination of malaria
B. increase as its selective advantage is increased
C. be reduced as its selective advantage is decreased
D. quickly disappear as its selective advantage is increased



Mosquito

—Higgins, 2000

Use the following additional information to answer the next two questions.



37. The row below that identifies process **1** and process **2** is

Row	Process 1	Process 2
A.	mitosis	meiosis
B.	mitosis	mitosis
C.	meiosis	mitosis
D.	meiosis	meiosis

38. The row below that identifies the chromosome number at the first stage and the chromosome number at the second stage is

Row	First stage	Second stage
A.	diploid	haploid
B.	diploid	diploid
C.	haploid	diploid
D.	haploid	haploid

Use the following additional information to answer the next two questions.

> Insecticides have been used to control mosquito populations in order to prevent the spread of malaria, but mosquitoes in malaria-infested areas are developing resistance to these insecticides. In addition, the antimalarial drug chloroquine, once very effective in protecting individuals against *Plasmodium,* has become ineffective, which has resulted in a resurgence of malaria. Scientists have identified a gene, called *cg2*, in *Plasmodium* that allows the *Plasmodium* to mount resistance to chloroquine. This research could be used by scientists to develop new versions of chloroquine that will sidestep the parasite's resistance and, therefore, effectively protect people against malaria.
>
> —from *Travis, 1997*

39. Some investigators have suggested that some strains of *Plasmodium* have become chloroquine-resistant because these strains have an increased ability to pump chloroquine from their bodies. Other investigators suggest that the resistance stems from changes in some strains of *Plasmodium* that prevent chloroquine from entering the parasites in the first place. These two suggestions can **best** be described as

A. theories
B. hypotheses
C. conclusions
D. observations

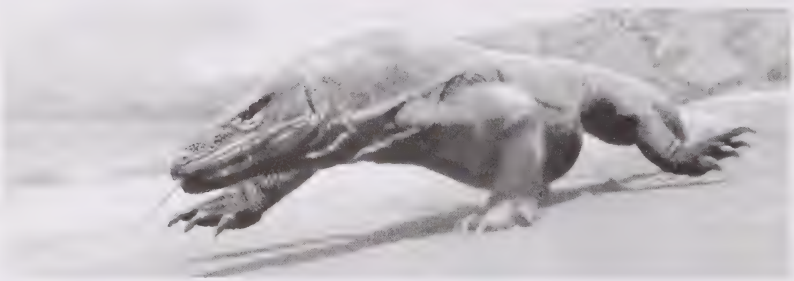
40. A possible reason that the *Plasmodium* parasite may have resistance to chloroquine is that the *cg2* gene codes for a protein that seems to play a role in membrane transport of the drug. If this is true, researchers may want to develop compounds that specifically block this resistance mechanism by

A. preventing mutation of the *cg2* gene
B. stimulating translation of the *cg2* gene
C. preventing transcription of the *cg2* gene
D. stimulating DNA replication of the *cg2* gene

Use the following information to answer the next five questions.

Komodo Island National Park is one of the last refuges of the Komodo dragon lizard. It is estimated that there are 3 500 Komodo dragons living in the 520 km^2 park. The Komodo dragon can grow to over three metres in length, weigh up to 70 kg, and run up to 20 km/h. These lizards grow slowly and can live up to 30 years. Female Komodo dragons mate once a year. Females may lay on the nest to protect the eggs. After the eggs hatch, young Komodo dragons live in trees until they are one year old to avoid being eaten by adult Komodo dragons and other predators.

—from *Ciofi, 1999*



—Azel, 1999

Use the following additional information to answer the next question.

Characteristics of Komodo Dragons

1 Classified as reptiles
2 Can live up to 30 years
3 Females lay between 20 and 30 eggs per year
4 Sexually mature at about six years of age
5 Females mate once a year
6 Over three metres in length and weigh up to 70 kg
7 The young live in trees until they are one year old
8 Adult Komodo dragons will eat young Komodo dragons

Numerical Response

7. Four characteristics of Komodo dragons that allow scientists to classify them as relatively K-selected strategists are _____, _____, _____, and _____.

(Record all **four digits** of your answer **in lowest-to-highest numerical order** in the numerical-response section on the answer sheet.)

Numerical Response

8. What is the population density of Komodo dragons in Komodo Island National Park?

Answer: _____ dragons/km^2

(Round and record your **answer to two decimal places** in the numerical-response section on the answer sheet.)

41. Because the retina of the Komodo dragon consists of only cones, Komodo dragons have a limited ability to see

A. colour
B. fine detail
C. prey at a distance
D. prey in low-intensity light

42. Komodo dragons have a poor range of hearing, partially because they have only one ossicle—the stapes. In humans, three ossicles work together to increase vibrations of the

A. cochlea
B. oval window
C. eustachian tube
D. tympanic membrane

Use the following additional information to answer the next question.

Komodo dragons have up to 50 strains of bacteria living on the meat stuck between their teeth. If a deer that has been bitten by a Komodo dragon manages to escape, it will die within a week as a result of bacterial infection. Komodo dragons can then feast on the dead deer. The Komodo dragons themselves are resistant to bacterial infection.

43. Which of the following rows identifies the relationship between the Komodo dragon and bacteria and the relationship between the deer and bacteria?

Row	Komodo Dragon and Bacteria	Deer and Bacteria
A.	mutualism	predator–prey
B.	parasitism	predator–prey
C.	mutualism	parasitism
D.	parasitism	parasitism

Use the following information to answer the next three questions.

> In heavily populated regions of Canada, the landscape is now dominated by what scientists call "invasive" non-native species. Horticultural expert Bill Granger has described the Norway maple as a "tree on steroids" because of its dense rooting system. This tree reaches sexual maturity quickly and spreads many seeds over a wide area. Another invasive species, pampas grass, is described by Dr. Spencer Barrett as an "excellent opportunist." Pampas grass relies on allies such as humans to cut out vegetative competition before it proceeds to dominate the landscape.
>
> —from *Cundiff, 1996*

44. By maintaining a stronghold on the environment and preventing further environmental changes, the Norway maple could be described as

A. a climax species
B. a pioneer species
C. a seral stage species
D. an intermediate species

45. The relationship exhibited between pampas grass and other native plants is

A. parasitism
B. commensalism
C. interspecific competition
D. intraspecific competition

46. Two strategies that give the Norway maple a high biotic potential are identified in row

Row	Strategy 1	Strategy 2
A.	is on steroids	reaches sexual maturity early
B.	reaches sexual maturity early	has large number of seeds
C.	spreads seeds over a large area	is on steroids
D.	spreads seeds over a large area	has strong root system

Norway Maple

—Brand, 2000

Pampas Grass

—Black, 2000

Use the following information to answer the next two questions.

Because insects are probably our main ecological competitors, scientists search for ways to get rid of them. Scientists have discovered that the hormone ecdysone, produced by the prothoracic gland of all insects, stimulates moulting and development into adult insects. The corpora allata gland secretes another hormone, juvenile hormone (JH), which inhibits the effect of ecdysone and maintains the insect juvenile state (pupa). Typically, insects winter as pupae and emerge as adults in spring.

—from *Wallace, Sanders, and Ferl, 1996*

47. An effective insecticide would be one that

A. inhibits JH in the spring
B. stimulates ecdysone in the spring
C. maintains a high level of JH in the fall
D. inhibits the release of ecdysone in the spring

48. Which of the following statements gives a valid prediction about the effect of the increased light in the spring on the hormones that control the emergence of an adult insect from its pupa case?

A. The light stimulates the release of JH.
B. The light inhibits the release of ecdysone.
C. The light stimulates the release of ecdysone.
D. The light inhibits the release of both ecdysone and JH.

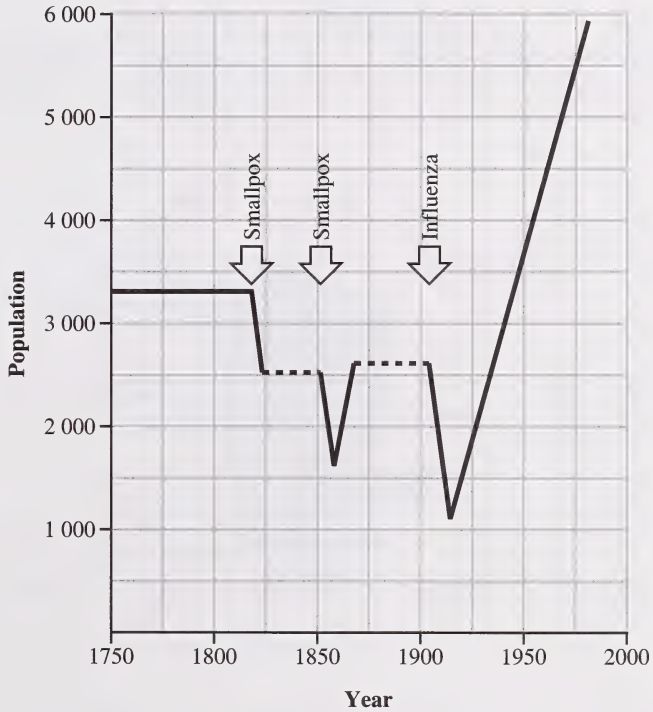
Pupa

Adult Emerging from Pupa

Use the information below and the information on page 28 to answer the next question.

The Blood Reserve is Canada's largest First Nations reserve. Prior to 1700, the Blood Tribe migrated within the area surrounding what is now Red Deer. By 1750, their migration area had changed to include more of southern Alberta and part of what is now Montana. During the 1800s, two smallpox epidemics killed almost the entire Blood population. These epidemics may have influenced the decision of the Blood Tribe to sign a treaty that led to the creation of the Blood Reserve in southern Alberta. After settling on the reserve, an influenza epidemic in 1918 further reduced the population to about 1 100. The present population is about 7 000 people.

Population of the Blood Tribe



—from *McLeod, 1987*

Blood Tribe Migration Patterns (Shaded areas)

Figure 1: Prior to 1700

Prior to 1700

Figure 2: 1750

1750

Figure 3: 1800

1800

—from *McLeod, 1987*

Written Response – 15% | Staple your word-processed response for **this** question to this page.

1. **a.** Examine the migration pattern maps for the Blood Tribe from prior to 1700 (Figure 1) and in 1750 (Figure 2). **Describe** a possible explanation for the change in migration pattern of the tribe over this period of time. **(1 mark)**

b. The graph shows that from 1750 to 1817, the population of the Blood Tribe was stable. **Describe** two factors that might have contributed to this stability. **(2 marks)**

c. **Describe** two possible explanations for the population change from 1920 to the present. **(2 marks)**

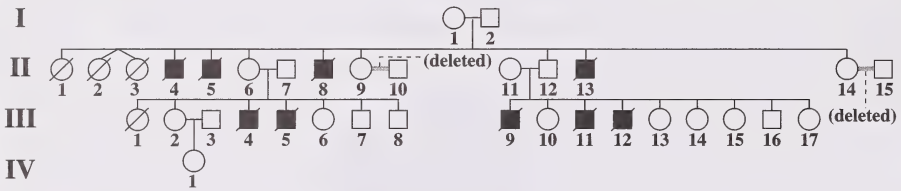
Use the following additional information to answer the next three parts of the question.

Ornithine transcarbamylase (OTC) deficiency has been studied in a large Blood Tribe family that lived in an isolated area on the Blood Reserve. This X-linked recessive disorder has not been identified in any members of the Blackfoot and Peigan Tribes that, together with the Blood Tribe, make up the Blackfoot Nation.

The disorder is the result of an incorrectly formed or absent OTC enzyme. The normal OTC enzyme is part of a pathway that converts ammonia (from excess protein in the diet) into urea in liver cells. When the OTC enzyme is defective, ammonia accumulates in the blood. Ammonia is toxic to the central nervous system. Untreated OTC deficiency produces symptoms of lethargy, coma, and eventual death in early infancy.

The error in the OTC gene is usually a point mutation. Treatment is successful in prolonging life. However, in the Blood Tribe family studied, the mutation is a result of a large deletion of a portion of the gene. This results in more severe symptoms of the deficiency. Of males with this mutation, 100% die in early infancy.

Partial Pedigree of Ornithine Transcarbamylase Deficiency in a Blood Tribe Family



Note: Some of the pedigree was deleted for ease in interpretation. Some of the deceased males are assumed to be OTC deficient, although diagnosis did not occur before death.

—from *McLeod, 1987*

—Adapted from *Emery and Rimoin's Principles and Practice of Medical Genetics 3/e,* volume 1, edited by Alan E.H. Emery, David L. Rimoin, J. Michael Connor, and Reed E. Pyeritz, pages 620–622, 1888, © 1997, by permission of the publisher Churchill Livingstone and by permission of Dr. David L. Rimoin.

d. **Explain** how it is possible that a male fetus with OTC deficiency could develop and the infant be born alive, yet become ill and die shortly after birth. **(2 marks)**

e. Assume that individuals **III-2** and **III-3** are expecting another child. **Construct two** Punnett squares to illustrate the two possible crosses, based on the mother's (III-2) two possible genotypes. **Calculate** the probability of this child being a son with OTC deficiency. (Provide a legend to identify the symbols used for the two alleles.) **(4 marks)**

Use the following additional information to answer the next part of the question.

A new therapy for OTC deficiency is being researched. In this therapy, viruses containing the normal OTC gene are injected into the bloodstream of an individual with OTC deficiency. These viruses travel to the liver and "infect" liver cells. Currently, this method has been successful in correcting OTC deficiency in mice. Approval is pending for human trials.

—Adapted from *Emery and Rimoin's Principles and Practice of Medical Genetics 3/e,* volume 1, edited by Alan E.H. Emery, David L. Rimoin, J. Michael Connor, and Reed E. Pyeritz, pages 620–622, 1888, © 1997, by permission of the publisher Churchill Livingstone and by permission of Dr. David L. Rimoin.

f. **Explain** how this viral therapy could be used to treat OTC deficiency in a patient. **(1 mark)**

Use the following information to answer the next question.

Herbal medications have recently been gaining popularity in Canada and the rest of the western world. Most of these medications have been used for thousands of years in Native and Asian medicine. Many people assume that "natural" herbal medications are "safer" than western-style medicines produced in chemistry laboratories. However, like other medicines, herbal remedies contain chemicals that interact with other medications. As well, many natural plants such as hemlock (which was used by Socrates to commit suicide) and milkweed contain toxins that can cause serious damage to the body or be fatal.

The Canadian Health Regulatory Board classifies edible substances as either food or drugs. Most herbs have not been tested by pharmaceutical companies because companies cannot patent a naturally growing plant. For herbs to be classified as drugs and for companies to make health claims about them, they must go through tests similar to other drugs. Current herbal therapy regulations classify herbs as food supplements and, therefore, they are not controlled in terms of purity, concentration, or testing for drug interactions. For example, because Ginkgo biloba inhibits platelet action, it should not be used in conjunction with Aspirin. Because herbal therapies are not classified as drugs, the cost to the consumer is not covered by most insurance companies or provincial health-care plans.

Consider the following sources.

Source 1: Wild Yam cream
In a report obtained from the Internet entitled "Everything your doctor hasn't shared with you about the causes of PMS and menopausal discomfort...and the revolutionary new natural solution," Beth Rosenthal describes her own personal experiences. She had very severe symptoms of premenstrual syndrome, which she attributed to supplements containing high levels of estrogen that her mother took during her pregnancy. (Symptoms of premenstrual syndrome include depression and premenstrual cramps.) Rosenthal began to use Wild Yam cream. She rubbed it into her skin three times a day for 21 of the 28 days of her menstrual cycle. She reported an increase in sex drive, a greater sense of well-being, and a dramatic decrease in the strength and pain of her menstrual cramps, all without side effects. She then began to advertise her story on the Internet so that she could sell the cream. She claims that the cream, which contains natural progesterone, overcomes "estrogen dominance," which is the cause of many women's menstrual cycle-related problems.

—from *Rosenthal, 2000*

Source 2: Ginkgo biloba
Ginkgo biloba has been used to treat nervous disorders such as mild Alzheimer's disease, short-term memory loss, lack of attention, and mild depression. Studies have shown that Ginkgo increases the flow of oxygenated blood to the brain. An abstract from *The Journal of the American Medical Association* obtained from the Internet describes a year-long study conducted by Dr. Pierre LeBars to determine both the effectiveness and the safety of this herb. In the study, 202 people with mild-to-severe Alzheimer's disease were given three different tests of memory-related mental abilities, specifically designed to diagnose Alzheimer's disease. Subjects were assigned to two parallel groups and were either administered Ginkgo extracts in a pill form or a placebo pill (containing no active ingredient). The study was a double-blind study conducted from several different medical centres. (In a double-blind study, neither the participants in the study nor the researchers know which group is receiving the placebo.) The cognitive tests were then readministered. The people who were given Ginkgo achieved significantly higher scores on all three tests after the year-long study than did those who were given the placebo. For example, 27% of those receiving the Ginkgo extract pills showed a four-point improvement on a cognitive scale called the ADAS-Cog (which tests memory function) compared with 14% of those taking the placebo pills. There was not a significant difference in either the number or the severity of side effects that were described by either group. The researchers concluded that Ginkgo was safe and resulted in modest but significant improvements in cognitive function in people with Alzheimer's disease.

—from *Le Bars, Katz, Berman, Itil, Freedman, and Schatzberg, 1997*

Written Response – 15% | Staple your word-processed response for **this** question to this page.

2. Write a unified response that addresses the following aspects of the use of herbal remedies in modern medicine.

- **Compare** the scientific validity of the two sources given.
- **Describe** the normal roles of estrogen and progesterone in the human female reproductive system. **Hypothesize** how Wild Yam cream would have to interact with a woman's hormones if it were to produce the benefits attributed to it by the source 1 article.
- **Describe** one advantage and one disadvantage of the current regulation of herbal therapies. **State** a revised regulation for herbal therapies, and **explain how** this revision would address the disadvantage(s) of the current regulations.

You have now completed the examination.
If you have time, you may wish to check your answers.

Credits

MC9–12 Glenn Zorpette. From "Extreme Sports, Sensation Seeking and the Brain" as found in *Scientific American Presents,* vol. 10, no. 2, 1999, pages 56–59. Adapted and reprinted with permission from Scientific American.

NR3–4 Nancy J. Alexander. From "Beyond the Condom: The Future of Male Contraception" as found in *Scientific American Presents,* vol. 10, no. 2, 1999, pages 80–85. Adapted and reprinted with permission from Scientific American.

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MC41–43 Claudio Ciofi. From "The Komodo Dragon" as found in *Scientific American,* vol. 280, no. 3, March 1999, pages 84–91. Adapted and reprinted with permission from Scientific American.

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MC47–48 Robert A. Wallace, Gerald P. Sanders, and Robert J. Ferl. From *Biology: The Science of Life,* Fourth Edition (HarperCollins College Publishers, 1996), pages 770–771. Adapted and reprinted by permission of Pearson Education, Inc.

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WR2 Beth Ellyn Rosenthal. From "Hot Flash: Wild Yam Cream" on http://www.meltdown.com/pms2.html, 2000. Reprinted with permission from Beth Ellyn Rosenthal.

Article by Pierre L. Le Bars, Martin M. Katz, Nancy Berman, Turan M. Itil, Alfred M. Freedman, and Alan F. Schatzberg. From "A Placebo-Controlled, Double-blind, Randomized Trial of an Extract of Ginkgo Biloba for Dementia" as found in the *JAMA Abstracts,* October 22, 1997, on http://www.ama-assn.org/sci-pubs/journals/archive/jama/vol_278/no_16/oc71278a.htm. Adapted and reprinted with permission from the American Medical Association.

BIOLOGY DATA

Symbols

Symbol	Description
D_p	population density
N	numbers of individuals in a population
A	area, space, or volume occupied by a population
t	time
Δ	change
r	biotic potential OR maximum per capita population growth rate
K	carrying capacity
$\frac{\Delta N}{\Delta t}$	a change in population size during time interval
>	greater than, dominant over
<	less than, recessive to

Symbol	Description
♂	male
♀	female
n	chromosome number
B, b	alleles; upper case is dominant, lower case is recessive
I^A, I^B, i	alleles, human blood type (ABO)
P	parent generation
F_1, F_2	first, second filial (generation)
p	frequency of dominant allele
q	frequency of recessive allele

Equations

Subject	Equation
Hardy–Weinberg principle	$p^2 + 2pq + q^2 = 1$
Population density	$D_p = \frac{N}{A}$
Change in population size	ΔN = (factors that increase pop.) – (factors that decrease pop.)
Per capita growth rate (time will be determined by the question)	$cgr = \frac{\Delta N}{N}$
Growth rate	$\frac{\Delta N}{\Delta t} = rN$ $\quad$ $\frac{\Delta N}{\Delta t} = rN\frac{(K - N)}{K}$

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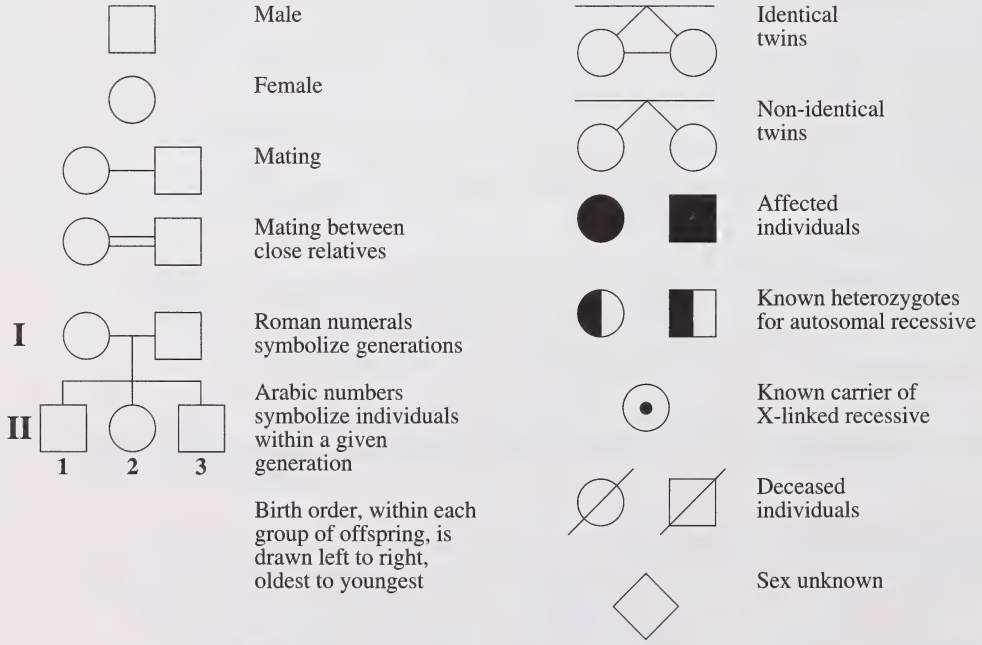
Revised April 1998

Abbreviations for Some Hormones

Hormone	Abbreviation
Adrenocorticotropin hormone	ACTH
Antidiuretic hormone	ADH
Follicle stimulating hormone	FSH
Human chorionic gonadotropin	HCG
Luteinizing hormone	LH (formerly ICSH in males)
Parathyroid hormone	PTH
Prolactin	PRL
Somatotropin (human growth hormone or growth hormone)	STH (HGH or GH)
Thyroid stimulating hormone	TSH

Pedigree Symbols



Messenger RNA Codons and Their Corresponding Amino Acids

First Base	Second Base				Third Base
	U	C	A	G	
U	UUU phenylalanine	UCU serine	UAU tyrosine	UGU cysteine	U
	UUC phenylalanine	UCC serine	UAC tyrosine	UGC cysteine	C
	UUA leucine	UCA serine	UAA stop **	UGA stop **	A
	UUG leucine	UCG serine	UAG stop **	UGG tryptophan	G
C	CUU leucine	CCU proline	CAU histidine	CGU arginine	U
	CUC leucine	CCC proline	CAC histidine	CGC arginine	C
	CUA leucine	CCA proline	CAA glutamine	CGA arginine	A
	CUG leucine	CCG proline	CAG glutamine	CGG arginine	G
A	AUU isoleucine	ACU threonine	AAU asparagine	AGU serine	U
	AUC isoleucine	ACC threonine	AAC asparagine	AGC serine	C
	AUA isoleucine	ACA threonine	AAA lysine	AGA arginine	A
	AUG methionine*	ACG threonine	AAG lysine	AGG arginine	G
G	GUU valine	GCU alanine	GAU aspartate	GGU glycine	U
	GUC valine	GCC alanine	GAC aspartate	GGC glycine	C
	GUA valine	GCA alanine	GAA glutamate	GGA glycine	A
	GUG valine	GCG alanine	GAG glutamate	GGG glycine	G

* Note: AUG is an initiator codon and also codes for the amino acid methionine.

** Note: UAA, UAG, and UGA are terminator codons.

Information About Nitrogen Bases

Nitrogen Base	Classification	Abbreviation
Adenine	Purine	A
Guanine	Purine	G
Cytosine	Pyrimidine	C
Thymine	Pyrimidine	T
Uracil	Pyrimidine	U

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Revised April 1998

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Biology 30

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